I. C. 6925 December 1936

DEPARTMENT OF THE INTERIOR

UNITED STATES BUREAU OF MINES
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SUGGESTED METHODS FOR THE REDUCTION OF MINE ACCIDENTS FROM THE VIEWPOINT OF THE SAFETY ENGINEER

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SUGGESTED METHODS FOR REDUCTION OF MINE ACCIDENTS FROM THE VIEWPOINT OF THE SAFETY ENGINEER[1]

By E. H. Denny[2]

INTRODUCTION

Reduction of mine accidents appears to depend upon essentially the same fundamentals, whether considered from the viewpoint of the mine operator, miner, State mine inspector, or safety engineer. Conditions of mine operation with respect to safety are governed in most States by a mining law, usually somewhat general in its provisions but more specific than laws dealing with other industries. Methods of mining development and practice evolved through experience have been handed down from generation to generation; many of these are intended to avoid injury to men and also loss of property. To carry out the intent of these bases of law and experience relating to safety supplemental measures and conditions are necessary. Among these may be: (1) Planned safety rules adapted to the mine and compliance by both officials and miners with such of these rules as pertain to their work; (2) a supervisory force adequate and competent to administer the mining laws and safety rules; (3) discipline adequate to secure compliance with safety measures; (4) safeguards against mechanical, electrical, falling, and other hazards; (5) mining operations planned with respect to safety of workers; (6) an active safety organization of officials and employees; (7) education of officials and employees in safety practices; and (8) an active sustained interest in safety by management and employees.

This paper presents the viewpoint of the safety engineer, though a safety engineer connected with a specific mine or group of mines would be in a better position than the writer to present the industrial engineer's thought. The application of the mine safety fundamentals just outlined will be given consideration from observations of methods used by safety engineers and supervisors.

The term "safety engineer" includes men of various duties, various degrees of experience, and various authority. Depending upon the size of the operation or the interest of the management in safety, the safety engineer may have accident prevention as his sole duty; he may be the head of a sizable safety organization; or he may be in part a claim agent; a statistician compiling figures for the enlightenment of the company, the public, or a mining institute meeting; a surveyor who must convince the miner that his scale of 10/10 equals 1 foot does not defraud the miner of 6 inches to every yard measured; or he may be by heavenly gift an orator capable of assuring the employees that "all's right with the world"; he may be a young engineer gaining experience while checking the observance of company rules and investigating accidents; or he may have the physical ills frequently resulting from several decades of mining experience and instead of a pension, the position of safety engineer has fallen to his lot. He may have mine-operating authority to correct immediately a dangerous condition or practice or he may have his recommendations officially disregarded at the monthly meeting or when the bottom of the desk basket is reached. He is likely to find that his viewpoint on accident reduction is considered unsound today because of youth and inexperience and unsound later because of old age and senility. He is likely to find the easiest course to be that of attributing to Providence and the carelessness of the worker the mishaps that result in the removal of a man to the hospital or the morgue.

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[1] The Bureau of Mines will welcome reprinting of this paper, provided the following footnote acknowledgment is used: "Reprinted from U.S. Bureau of Mines Information Circular 6925."
Presented at the Mine Inspectors' Institute of America, Denver, Colo., June 29, 1936.

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SAFETY ENGINEERING METHODS

All occupations have their drawbacks, even that of State mine inspector. Let us assume that the safety engineer is devoting all his time to accident reduction, for a mining company providing a fairly large tonnage and having a management determined to mine coal safely and prepared to make the necessary expenditures. The mine safety engineer is then likely to employ some of the following methods toward accident reduction.

It may seem superfluous to list as the first mine-safety engineering method a thorough knowledge and understanding of the State mining regulations relating to safety and the ability to impart to officials and men such portions as concern their work. Where the underground officials are certified by the State, as is usually the case in coal-mining work, knowledge of the law is widespread. Metal-mining safety law contain no provision for State examination and certification of underground officials. Often safety laws are assembled with a large amount of data on statutes dealing with claim location and property rights, and underground officials might be hard-pressed to find a copy of the law - let alone know it. Certainly a knowledge of the law and of the carrying out of its provisions by mine officials and miners is an important safety-engineering method.

Assembly of safety rules adapted to the particular mining operation and selection of measures to insure that they are carried out by mine officials and miners may be termed a safety engineering method. Such rules supplement the State law. They may be few in number or many, depending upon the size and complexity of the mining operation. Sometimes a committee of miners prepares the rules for company adoption, and such assistance from the employees in the discussion and preparation of proposed rules is likely to promote better compliance. In any case, safety rules need frequent study as to applicability; they have no value unless understood and carried out.

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Safeguards against mechanical, electrical, falling, and other similar hazards may play a more important part in accident reduction than figures indicate; a good system of guards about all machinery exposed to man contact impresses the miner with the company's interest in his safety and tends to make him think of safety also. The safety engineer must consider the problems introduced by the constantly increasing use of electricity underground with workers in proximity to power lines having a potential of 220 to 500 volts or more. In many mines he has difficulty in insuring that ordinary trolley wires are guarded where men have to pass under them, although guarding them for their full length is usually the only method that will prevent an eventual fatality. He can advocate a frequent inspection of all electrical installations with proper surface repair of equipment and point out that proper inspection and maintenance will save money and probably life.

He can try to see that electrical installations are properly made and maintained, not only in show places but also in remote parts of the mine where sometimes a little pump is laboring manfully with fuses of baling wire, with wiring hung on nails, props, or canvas, and the coal rib or a prop closely protecting the motor. He can be on the alert before the accident to place guards against falls of persons through unprotected ore chutes, raises, winzes, and open stopes, so common to metal mines and not uncommon in and about coal mines.

The safety engineer may be able at least to suggest changes in methods of mining operation that will increase safety. Generally accepted practices nevertheless may not be the safest. Using a metal mine as example, a trip rider was killed by returning too soon to a "pop" shot in a boulder on the top of a car. This suggested that there should have been no rocks coming through the chute into the car big enough to have to be shot and that a smaller screen or grizzly, with better breaking on an upper level, would have made such an accident impossible on a haulage tunnel where speed in moving ore was considered essential.

Although rules have been prepared that would hold accidents from falls of roof and haulage to a minimum, in general these are still the major causes of mine accidents and hence a serious problem to the safety engineer. The roof-fall problem requires adequate timbering standards to be set and followed; this in turn requires strict supervision by the management, and the best of practice by the individual miner. Mechanical mining permits good supervision of timbering and of rapid mining, with less time for the roof to weaken, but it also exposes more men in a single place; also, some loading equipment requires or is best adapted for work in a large area unencumbered by props. The safety engineer can consider the mine-haulage layout with an eye to derailments, wrecks, abnormal spillage points, clearance, and proximity of timber as a guide to probable future injury of men. Rail weight and character of roadbed, grades, and illumination at curves, switches, and hills are other points for study. Conveyor and belt haulage will also interest him as a recent moving picture of belt haulage did me; members of the crew were riding out of a place on the belt sitting on their haunches with knees, picks, and shovels resting near their chins, but no detail was shown as to the discharge of the crew from the conveyor.

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Safety engineering will call for good ventilation not only to minimize methane and black-damp hazards but also to enable the miner to turn out a full day's work in cool, moving air. Many serious mine explosions have occurred because a little gas accumulated near the face and was mixed with just enough fresh air to cause ignition with violence. The safety engineer will want the working sections of the mine swept with measurable currents of fresh air split in accordance with good practice. He will not want most of the mine-air supply used in supposed ventilation of worked-out or abandoned territory but will have such old territory thoroughly sealed off and at the same time have provision made for proper examination of the gases behind such seals. He will particularly watch fire-seal areas, knowing that they may contain potential or actual flame, and gases which when mixed with air can, if ignited, cause more damage than the blowing up of an explosives magazine. He will know the composition of the mine air at the faces and in returns with respect to methane content, the quantity circulating in the last crosscut of each entry, and the amounts of methane, carbon dioxide, oxygen, and carbon monoxide behind the seals. He will use sampling and analytical methods and portable devices for relatively accurate determination of mine gases. He will know the characteristics of the mine fan, its housing, and the adequacy of the mine openings and passages to carry the volume which it circulates, and he will study the desirability of reserve motive power and a reserve fan.

If the mine is equipped with small auxiliary fans or blowers he will marvel at the ease with which they may be moved from an unsafe to a safe location and vice-versa. If he is wise he will have the fan motor and switch set in a strong current of fresh air and away from contact with ribs and props; he will remove the kinks from the tubing and assure himself that the motor will keep going until cutting and blasting are completed.

Safety engineering has always had the problem of infrequent but usually serious accidents from explosives, particularly when detonator and "powder" interact before desired. The safety engineer must pay attention to the safe transportation, distribution, temporary underground storage, and use of explosives with the principle in mind that the fewer men, other than those necessary, handling the explosive or in proximity to it the less the hazard. Much mechanical mining involves frequent blasting during the shift, and a definite tendency to "let down" on underground storage and transportation practice follows. Blasting during the shift necessitates proper guarding of shots to avoid injury to men; also any shot of a flame-producing explosive (including all permissible explosives) can ignite explosive gas if present, and poorly placed shots can ignite coal dust.

Mine explosions can result in the death of all underground employees and the destruction of property. The safety engineer will insure adequate ventilation of a mine; he will also minimize the coal-dust hazard by having roadways cleaned, dusty ribs and timbers washed down, and all mine passageways, air courses, and workings rock-dusted to within a few feet of the face. He will have much dust formation prevented by the application of water on the cutter bar, sprinkling of the ribs and gob near the face, spraying of trips, and use of tight cars with limited or no topping.

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Underground fire-protection measures are simplified by the water lines used in the working faces. The safety engineer will have suitable pipe connections underground with hose available, fireproofing of underground stables and electrical equipment stations, fire extinguishers of the carbon tetrachloride or other nonconducting type near electrical stations, electric miners' lamps, concrete drift portals and shafts, and all wiring on insulators or in conduit. He will have a good supply of portable fire-fighting equipment on the surface and men on the surface and underground who have studied what to do in event of spontaneous or unexpected fire.

The safety engineer also freely studies and uses accident statistics of his own company and other companies to reduce accidents. He first classifies his accidents as to the standard direct causes and computes the accident frequency and severity rates. He studies the records of mine sections and mine bosses, and he considers the natural conditions in the various mines or sections. He requires a report of all accidents and proper treatment thereof; he secures proper medical treatment for the injured and yet tries to get the injured man back to work as soon as he is fit, but only if he is fit, thus conserving funds of the insurance company and numerous benefit societies as well as helping his accident-severity record. He charges permanent partial disabilities, permanent total disabilities, and fatalities on a definite time-lost basis intelligible to all and does not make a "joke" of the record by putting an injured man back at some light job and calling him well on the accident-report sheet. From time to time he totals the compensation and medical cost of accidents and considers how much they really cost the company and the injured men. He makes an investigation of at least all serious accidents, considers whether the ascribed causes of the accidents were the real ones, what other causes enter, and what measures to take to avoid repetition.

CONCLUSION

Various methods employed by the safety engineer to reduce specific causes of accidents have been considered in this paper. To get these methods carried out he works in many and devious ways with management, underground officials, and men. Obviously the methods suggested cannot be carried out by any one man, and the safety engineer attains success in reducing accidents by getting the "other fellow" singly and collectively to do the work. The interest of management is held by a report that points out results achieved, including life and money saved, of dangerous conditions corrected, of accidents investigated and cooperation received. The mine official is told at meetings (and by individual contact) of comparative accident records, of both good and bad conditions noted in his section, of changes needed, and of work planned. The employee is kept interested in his own safety through safety meetings and through a company safety organization in which he has a definite voice, through workers' safety committees, through safety contests with rewards to miners and officials, through numerous personal contacts, through company publications, bulletins, posters and letters, and through the thought that upon the individual lies a large responsibility for safety.

These are some of the methods advocated for the reduction of mine accidents by the safety engineer - he can fill in remaining time by perusal of mining and safety publications and by contact with others in his industry at meetings like these. He contributes his part toward the joint safety effort of mine operator, miner, insurance company, and State and federal governmental agencies, whose combined efforts are achieving a definite reduction in our mine accident rate and saving a large number of miners from suffering and accidental death.